

## CLAIMS

We claim:

- 1           1.    An analog-to-digital converter comprising:
  - 2           a waveguide adapted to receive an optical signal and an
  - 3           analog electrical signal, wherein the waveguide is adapted to
  - 4           provide a desired time delay to the optical signal based on a
  - 5           value of the analog electrical signal;
  - 6           means for receiving the optical signal with the time delay
  - 7           and providing an output optical signal having a wavelength based
  - 8           on the time delay;
  - 9           a demultiplexer adapted to route the output optical signal
  - 10          to one of a plurality of optical paths based on the wavelength;
  - 11          photodetectors adapted to convert optical signals in the
  - 12          optical paths into electrical signals; and
  - 13          a discriminating circuit adapted to receive the electrical
  - 14          signals and determine which of the optical paths provided the
  - 15          output optical signal to provide a digital electrical output
  - 16          signal corresponding to the analog electrical signal.

- 1           2.    The analog-to-digital converter of Claim 1, further
- 2           comprising a fiber optic circulator adapted to provide the
- 3           optical signal to the waveguide and the optical signal with the
- 4           time delay to the receiving means.

1           3.     The analog-to-digital converter of Claim 1, wherein  
2     the receiving means comprises:

3           a fiber assembly adapted to provide self-phase modulation  
4     and dispersion to the optical signal or to an optical clock  
5     signal; and

6           an optical switch adapted to receive the optical signal and  
7     the optical clock signal and provide the output optical signal.

1           4.     The analog-to-digital converter of Claim 3, further  
2     comprising filters adapted to filter the optical signals in the  
3     optical paths.

1           5.     The analog-to-digital converter of Claim 1, wherein  
2     the receiving means comprises:

3           dispersive elements adapted to impart a chirp onto the  
4     optical signal and an optical clock signal; and

5           an optical nonlinearity device adapted to receive the  
6     optical signal and the optical clock signal and to provide the  
7     output optical signal.

1           6.     The analog-to-digital converter of Claim 5, wherein  
2     the frequency of the optical signal and the optical clock signal  
3     are slewed at the same rate but in opposite directions, at the  
4     same rate and direction, or at a different rate but in the same  
5     direction.

1        7.     The analog-to-digital converter of Claim 1, wherein  
2     the waveguide comprises a chirped distributed Bragg reflector.

1        8.     The analog-to-digital converter of Claim 1, wherein  
2     the waveguide comprises at least one layer of an electro-  
3     optically active material having a refractive index controlled  
4     by the analog electrical signal.

1        9.     A method of providing analog-to-digital conversion,  
2     the method comprising:

3        providing an optical signal pulse having a time delay  
4     controlled by an analog electrical signal;

5        converting the optical signal pulse with the time delay to  
6     an optical output signal pulse having a wavelength based on the  
7     time delay; and

8        providing a digital electrical output signal, corresponding  
9     to the wavelength of the optical output signal pulse, wherein a  
10    value of the digital electrical output signal is based on a  
11    value of the analog electrical signal.

1        10.    The method of Claim 9, further comprising:

2        routing the optical output signal pulse to one of a  
3        plurality of paths based on the wavelength;

4        converting the optical output signal pulse to an electrical  
5        signal; and

6        determining the value of the digital electrical output  
7        signal based on which path provided the optical output signal  
8        pulse.

1        11.    The method of Claim 10, further comprising filtering  
2        the optical output signal pulse.

1        12.    The method of Claim 10, wherein the converting  
2        comprises providing self-phase modulation and dispersion to the  
3        optical signal pulse with the time delay.

1        13.    An analog-to-digital converter system comprising:

2        an analog delay modulator adapted to receive an analog  
3        electrical signal and to provide optical pulses having time  
4        delays determined by the analog electrical signal;

5        a fiber assembly adapted to receive the optical pulses or  
6        clock pulses and provide self-phase modulation and dispersion;

7        an optical switch, coupled to the fiber assembly, adapted  
8        to receive the optical pulses and the clock pulses and provide  
9        output optical pulses having wavelengths corresponding to the  
10       time delays; and

11        a discriminator adapted to receive the output optical  
12 pulses and provide digital electrical output signals based on  
13 the wavelengths.

1        14. The system of Claim 13, wherein values of the digital  
2 electrical output signals are based on values of the analog  
3 electrical signal.

1        15. The system of Claim 13, wherein the analog delay  
2 modulator comprises:

3        an optical pulse generator adapted to provide the optical  
4 pulses; and

5        a waveguide adapted to receive the optical pulses and the  
6 analog electrical signal and apply the time delays to the  
7 optical pulses under the control of the analog electrical  
8 signal.

1        16. The system of Claim 15, wherein the analog delay  
2 modulator further comprises a fiber optic circulator adapted to  
3 route the optical pulses to and from the waveguide.

1        17. The system of Claim 16, wherein the waveguide  
2 comprises a chirped distributed Bragg reflector.

1        18.    The system of Claim 13, wherein the discriminator  
2 comprises:

3        a demultiplexer adapted to route the output optical pulses  
4 to one of a plurality of paths based on the wavelength;

5        photodetectors adapted to convert the output optical pulses  
6 to electrical signals; and

7        a discriminating circuit adapted to receive the electrical  
8 signals and provide the digital electrical output signals based  
9 on which path carried the corresponding output optical pulses.

1        19.    The system of Claim 18, further comprising filters,  
2 coupled to the photodetectors, and adapted to filter the output  
3 optical pulses.

1        20.    The system of Claim 13, wherein the demultiplexer  
2 comprises an arrayed-waveguide grating demultiplexer or a  
3 wavelength-independent star coupler.

1        21.    The system of Claim 13, wherein the discriminating  
2 circuit provides frequency shift keying detection.

1        22.    The system of Claim 13, wherein the optical pulses are  
2 pulse position modulated optical signals.

1           23.   An analog-to-digital converter comprising: /  
2           an optical pulse generator adapted to receive an analog  
3   electrical signal and provide optical pulses having time delays  
4   determined by the analog electrical signal; and  
  
5           an optical pulse discriminator adapted to receive the  
6   optical pulses and provide a digital electrical signal, wherein  
7   the digital electrical signal is based on the analog electrical  
8   signal.

1           24.   The analog-to-digital converter of Claim 23, wherein  
2   values of the digital electrical signal are digital  
3   representations of corresponding values of the analog electrical  
4   signal.

1           25.   The analog-to-digital converter of Claim 23, wherein  
2   the optical pulse generator comprises a waveguide adapted to  
3   receive the optical pulses and provide the time delays to the  
4   optical pulses under control of the analog electrical signal.

1           26.   The analog-to-digital converter of Claim 25, wherein  
2   the waveguide comprises at least one layer of electro-optically  
3   active material having refractive index variations which form a  
4   chirped distributed Bragg reflector, wherein the analog  
5   electrical signal controls an index of refraction of the  
6   electro-optically active material.

1        27. The analog-to-digital converter of Claim 25 wherein  
2 the optical pulse generator further comprises a fiber optic  
3 circulator adapted to direct the optical pulses to and from the  
4 waveguide.

1        28. The analog-to-digital converter of Claim 23, wherein  
2 the optical pulse discriminator comprises:

3        a fiber assembly adapted to spectrally broaden and chirp  
4 the optical pulses or optical clock pulses;

5        an optical switch adapted to receive the optical pulses and  
6 the optical clock pulses, after the optical pulses or the  
7 optical clock pulses are spectrally broadened and chirped by the  
8 fiber assembly, and provide an optical output pulse  
9 corresponding to each of the optical pulses and having a  
10 wavelength based on the time delay of the optical pulse;

11       a demultiplexer adapted to direct each of the optical  
12 output pulses to one of a plurality of optical paths based on  
13 its wavelength;

14       photodetectors adapted to convert the optical output pulses  
15 to electrical output signals; and

16       a discriminating circuit adapted to receive each of the  
17 electrical output signals and provide the corresponding digital  
18 electrical signal.



1        29. The analog-to-digital converter of Claim 28, wherein  
2 the corresponding digital electrical signal for each of the  
3 electrical output signals is based on which of the optical paths  
4 carried the corresponding optical output pulse, wherein a value  
5 of the digital electrical signal is a digital representation of  
6 a corresponding value of the analog electrical signal.

1        30. The analog-to-digital converter of Claim 23, wherein  
2 the optical pulse discriminator comprises:

3        dispersive elements adapted to impart a chirp onto the  
4 optical pulses and optical clock pulses;

5        an optical nonlinearity device adapted to receive the  
6 optical pulses and the optical clock pulses and provide an  
7 optical output pulse corresponding to each of the optical pulses  
8 and having a wavelength based on the time delay of the optical  
9 pulse;

10       a demultiplexer adapted to direct each of the optical  
11 output pulses to one of a plurality of optical paths based on  
12 its wavelength;

13       photodetectors adapted to convert the optical output pulses  
14 to electrical output signals; and

15       a discriminating circuit adapted to receive each of the  
16 electrical output signals and provide the corresponding digital  
17 electrical signal.

1        31. The analog-to-digital converter of Claim 30, wherein  
2 the corresponding digital electrical signal for each of the  
3 electrical output signals is based on which of the optical paths  
4 carried the corresponding optical output pulse, wherein a value  
5 of the digital electrical signal is a digital representation of  
6 a corresponding value of the analog electrical signal.